MySQL 8 Observability

(Also Query Troubleshooting with PMM Demo)

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Why Observability

Many Non Easily Repeatable Issues in Complex Systems

Resolving and Preventing Issues Requires Understanding



Data Capture

Ongoing Data Capture (Monitoring)

Temporary Data Capture (Debugging)



Comprehensive View Needed

You Can't just use at MySQL Alone

OS Issues, Hardware Issues are often root cause

Application issues can't be ignored

Background Load



MySQL 8 at Focus

MySQL 8 Data Sources

SHOW STATUS

INFORMATION SCHEMA

PERFORMANCE SCHEMA

LOGS

EXPLAIN

OPTIMIZER TRACE



SHOW [GLOBAL] STATUS

Existed Forever

Shows 400+ status variables

Most are counters, some are gauges, some text

Session and Global Scope

Also available as Performance Schema Table

https://dev.mysql.com/doc/refman/8.0/en/server-status-variables.html



Global And Session

```
mysql> select * from performance_schema.global_status where variable_name='Questions';
+---------------+----------------+
| VARIABLE_NAME | VARIABLE_VALUE |
+---------------+----------------+
| Questions     | 82457893       |
+---------------+----------------+
1 row in set (0.01 sec)

mysql> select * from performance_schema.session_status where variable_name='Questions';
+---------------+----------------+
| VARIABLE_NAME | VARIABLE_VALUE |
+---------------+----------------+
| Questions     | 153            |
+---------------+----------------+
1 row in set (0.00 sec)
```




Trust but Verify

```
mysql> select * from performance_schema.session_status where
variable_name like "%rows%";
+--------------------------+----------------+
| VARIABLE_NAME            | VARIABLE_VALUE |
+--------------------------+----------------+
| Innodb_rows_deleted      | 14553828       |
| Innodb_rows_inserted     | 15840851       |
| Innodb_rows_read         | 1927758552     |
| Innodb_rows_updated      | 29290781       |
| Mysqlx_rows_sent         | 0              |
| Not_flushed_delayed_rows | 0              |
| Sort_rows                | 19             |
+--------------------------+----------------+
7 rows in set (0.00 sec)
```




Status-Profiling Query

```
mysql> select * from performance_schema.session_status where variable_name like "%Handler_read_next%";
+-------------------+----------------+
| VARIABLE_NAME     | VARIABLE_VALUE |
+-------------------+----------------+
| Handler_read_next | 11             |
+-------------------+----------------+
1 row in set (0.00 sec)

mysql> select count(*) from orders1;
+----------+
| count(*) |
+----------+
|    75653 |
+----------+
1 row in set (0.02 sec)

mysql> select * from performance_schema.session_status where variable_name like "%Handler_read_next%";
+-------------------+----------------+
| VARIABLE_NAME     | VARIABLE_VALUE |
+-------------------+----------------+
| Handler_read_next | 75664          |
+-------------------+----------------+
1 row in set (0.00 sec)
```




VMSTAT Like output for MySQL

```
root@mysql3:~# mysqladmin extended -i1 -r | grep Questions
| Questions                              | 82525506
| Questions                              | 378
| Questions                              | 519
| Questions                              | 591
```




With Percona Toolkit

```
root@mysql3:~# pt-mext -r -- mysqladmin ext -i1 -c5
…
Bytes_received                      13701143412           54076          101332           44687
Bytes_sent                          19638518220           98678          131670           94501
…
Innodb_buffer_pool_pages_data             27615             -58              -3               2
Innodb_buffer_pool_pages_dirty            13643             -58              86             -26
Innodb_buffer_pool_pages_flushed       23741158             182             145             123
Innodb_buffer_pool_pages_free               964              60               0              -2
```




INFORMATION_SCHEMA

60+ Tables

Some are Schema Related

Others are Performance Statistics



INFORMATION SCHEMA – Shema Info

```
mysql> select * from TABLES limit 1 \G
*************************** 1. row ***************************
  TABLE_CATALOG: def
   TABLE_SCHEMA: information_schema
     TABLE_NAME: CHARACTER_SETS
     TABLE_TYPE: SYSTEM VIEW
         ENGINE: NULL
        VERSION: 10
     ROW_FORMAT: NULL
     TABLE_ROWS: 0
 AVG_ROW_LENGTH: 0
    DATA_LENGTH: 0
MAX_DATA_LENGTH: 0
   INDEX_LENGTH: 0
      DATA_FREE: 0
 AUTO_INCREMENT: NULL
    CREATE_TIME: 2019-05-27 20:33:04
    UPDATE_TIME: NULL
     CHECK_TIME: NULL
TABLE_COLLATION: NULL
       CHECKSUM: NULL
 CREATE_OPTIONS:
  TABLE_COMMENT:
1 row in set (0.00 sec)
```




INFORMATION SCHEMA – Metrics

```
mysql> select * from innodb_metrics limit 1 \G
*************************** 1. row ***************************
           NAME: metadata_table_handles_opened
      SUBSYSTEM: metadata
          COUNT: 20040
      MAX_COUNT: 20040
      MIN_COUNT: NULL
      AVG_COUNT: 0.10970542669608203
    COUNT_RESET: 20040
MAX_COUNT_RESET: 20040
MIN_COUNT_RESET: NULL
AVG_COUNT_RESET: NULL
   TIME_ENABLED: 2019-06-11 19:01:11
  TIME_DISABLED: NULL
   TIME_ELAPSED: 182671
     TIME_RESET: NULL
         STATUS: enabled
           TYPE: counter
        COMMENT: Number of table handles opened
1 row in set (0.00 sec)
```




Note on Innodb Metrics

- **While Looks similar to SHOW STATUS is not enabled by default**
  - innodb_monitor_enable=all



Performance Shema

- The “Instrumentation of Choice” in MySQL
- 100+ Tables
- Some information Capture Enabled by Default
- Can enable more instrumentation permanently or temporary
- Overhead can be high



Performance Schema Configuration

```
mysql> show tables like "setup%";
+----------------------------------------+
| Tables_in_performance_schema (setup%) |
+----------------------------------------+
| setup_actors                           |
| setup_consumers                        |
| setup_instruments                      |
| setup_objects                          |
| setup_threads                          |
+----------------------------------------+
5 rows in set (0.02 sec)
```




Actors – What users should be profiled ?

```
mysql> select * from setup_actors;
+------+-------+------+---------+---------+
| HOST | USER  | ROLE | ENABLED | HISTORY |
+------+-------+------+---------+---------+
| %    | %     | %    | YES     | YES     |
+------+-------+------+---------+---------+
1 row in set (0.00 sec)
```




What Summaries should be produced

```
mysql> select * from setup_consumers;
+----------------------------------+---------+
| NAME                             | ENABLED |
+----------------------------------+---------+
| events_stages_current            | NO      |
| events_stages_history            | NO      |
| events_stages_history_long       | NO      |
| events_statements_current        | YES     |
| events_statements_history        | YES     |
| events_statements_history_long   | NO      |
| events_transactions_current      | YES     |
| events_transactions_history      | YES     |
| events_transactions_history_long | NO      |
| events_waits_current             | NO      |
| events_waits_history             | NO      |
| events_waits_history_long        | NO      |
| global_instrumentation           | YES     |
| thread_instrumentation           | YES     |
| statements_digest                | YES     |
+----------------------------------+---------+
15 rows in set (0.00 sec)
```




Instruments - Instrumentation Points

- 1200+ Instruments
- 800 enabled by default and almost 300 timed

```
mysql> select * from setup_instruments limit 2 \G
*************************** 1. row ***************************
         NAME: wait/synch/mutex/pfs/LOCK_pfs_share_list
      ENABLED: NO
        TIMED: NO
   PROPERTIES: singleton
   VOLATILITY: 1
DOCUMENTATION: Components can provide their own performance_schema tables. This lock protects the list of such tables definitions.
*************************** 2. row ***************************
         NAME: wait/synch/mutex/sql/TC_LOG_MMAP::LOCK_tc
      ENABLED: NO
        TIMED: NO
   PROPERTIES:
   VOLATILITY: 0
DOCUMENTATION: NULL
2 rows in set (0.00 sec)
```




What Objects to Instrument

```
mysql> select * from setup_objects;
+-------------+--------------------+-------------+---------+-------+
| OBJECT_TYPE | OBJECT_SCHEMA      | OBJECT_NAME | ENABLED | TIMED |
+-------------+--------------------+-------------+---------+-------+
| EVENT       | mysql              | %           | NO      | NO    |
| EVENT       | performance_schema | %           | NO      | NO    |
| EVENT       | information_schema | %           | NO      | NO    |
| EVENT       | %                  | %           | YES     | YES   |
| FUNCTION    | mysql              | %           | NO      | NO    |
| FUNCTION    | performance_schema | %           | NO      | NO    |
| FUNCTION    | information_schema | %           | NO      | NO    |
| FUNCTION    | %                  | %           | YES     | YES   |
| PROCEDURE   | mysql              | %           | NO      | NO    |
| PROCEDURE   | performance_schema | %           | NO      | NO    |
| PROCEDURE   | information_schema | %           | NO      | NO    |
| PROCEDURE   | %                  | %           | YES     | YES   |
| TABLE       | mysql              | %           | NO      | NO    |
| TABLE       | performance_schema | %           | NO      | NO    |
| TABLE       | information_schema | %           | NO      | NO    |
| TABLE       | %                  | %           | YES     | YES   |
| TRIGGER     | mysql              | %           | NO      | NO    |
| TRIGGER     | performance_schema | %           | NO      | NO    |
| TRIGGER     | information_schema | %           | NO      | NO    |
| TRIGGER     | %                  | %           | YES     | YES   |
+-------------+--------------------+-------------+---------+-------+
20 rows in set (0.01 sec)
```




What Threads do we want to Instrument

```
mysql> select * from setup_threads;
+------------------------------------------------+---------+---------+------------+------------+---------------+
| NAME                                           | ENABLED | HISTORY | PROPERTIES | VOLATILITY | DOCUMENTATION |
+------------------------------------------------+---------+---------+------------+------------+---------------+
| thread/performance_schema/setup                | YES     | YES     | singleton  |          0 | NULL          |
| thread/sql/bootstrap                           | YES     | YES     | singleton  |          0 | NULL          |
| thread/sql/manager                             | YES     | YES     | singleton  |          0 | NULL          |
| thread/sql/main                                | YES     | YES     | singleton  |          0 | NULL          |
| thread/sql/one_connection                      | YES     | YES     | user       |          0 | NULL          |
| thread/innodb/srv_error_monitor_thread         | YES     | YES     |            |          0 | NULL          |
| thread/innodb/srv_lock_timeout_thread          | YES     | YES     |            |          0 | NULL          |
….
| thread/myisam/find_all_keys                    | YES     | YES     |            |          0 | NULL          |
| thread/mysqlx/acceptor_network                 | YES     | YES     |            |          0 | NULL          |
| thread/mysqlx/worker                           | YES     | YES     |            |          0 | NULL          |
| thread/sql/slave_io                            | YES     | YES     | singleton  |          0 | NULL          |
| thread/sql/slave_sql                           | YES     | YES     | singleton  |          0 | NULL          |
| thread/sql/slave_worker                        | YES     | YES     | singleton  |          0 | NULL          |
+------------------------------------------------+---------+---------+------------+------------+---------------+
49 rows in set (0.00 sec)
```




Example of Performance Schema Data

```
mysql> select * from events_statements_current  limit 1 \G
*************************** 1. row ***************************
             THREAD_ID: 9789
              EVENT_ID: 49
          END_EVENT_ID: 49
            EVENT_NAME: statement/sql/show_status
                SOURCE: init_net_server_extension.cc:95
           TIMER_START: 185174708798157000
             TIMER_END: 185174709926911000
            TIMER_WAIT: 1128754000
             LOCK_TIME: 98000000
              SQL_TEXT: SHOW GLOBAL STATUS
                DIGEST: 070e38632eb4444e50cdcbf0b17474ba801e203add89783a24584951442a2317
           DIGEST_TEXT: SHOW GLOBAL STATUS
        CURRENT_SCHEMA: NULL
…
     NESTING_EVENT_TYPE: NULL
    NESTING_EVENT_LEVEL: 0
          STATEMENT_ID: 84449971
1 row in set (0.00 sec)
```




Too Hard to Use ?

Meet Sys Schema



Sys Schema

Views and Stored Procedures to access Performance Schema Data



Views for Humans

```
mysql> show tables;
+-----------------------------------------------+
| Tables_in_sys                                 |
+-----------------------------------------------+
| host_summary                                  |
| host_summary_by_file_io                       |
| host_summary_by_file_io_type                  |
| host_summary_by_stages                        |
| host_summary_by_statement_latency             |
| host_summary_by_statement_type                |
| innodb_buffer_stats_by_schema                 |
| innodb_buffer_stats_by_table                  |
| innodb_lock_waits                             |
| io_by_thread_by_latency                       |
| io_global_by_file_by_bytes                    |
…
```




Views for Machines

```
mysql> show tables like "x$%";
+-----------------------------------------------+
| Tables_in_sys (x$%)                           |
+-----------------------------------------------+
| x$host_summary                                |
| x$host_summary_by_file_io                     |
| x$host_summary_by_file_io_type                |
| x$host_summary_by_stages                      |
| x$host_summary_by_statement_latency           |
| x$host_summary_by_statement_type              |
| x$innodb_buffer_stats_by_schema               |
| x$innodb_buffer_stats_by_table                |
| x$innodb_lock_waits                           |
| x$io_by_thread_by_latency                     |
| x$io_global_by_file_by_bytes                  |
```




Example for Humans

```
mysql> select * from session limit 1 \G
*************************** 1. row ***************************
                thd_id: 7101
               conn_id: 7060
                  user: app2@li1306-116.members.linode.com
                    db: tpcc4
               command: Sleep
                 state: NULL
                  time: 7
     current_statement: NULL
     statement_latency: NULL
              progress: NULL
          lock_latency: 0 ps
         rows_examined: 0
             rows_sent: 0
         rows_affected: 0
            tmp_tables: 0
       tmp_disk_tables: 0
             full_scan: NO
        last_statement: COMMIT
last_statement_latency: 97.95 us
        current_memory: 119.71 KiB
             last_wait: NULL
     last_wait_latency: NULL
                source: NULL
           trx_latency: 3.10 ms
             trx_state: COMMITTED
        trx_autocommit: NO
                   pid: 14124
          program_name: NULL
1 row in set (0.23 sec)
```




Example for Machines

```
mysql> select * from x$session limit 1 \G
*************************** 1. row ***************************
                thd_id: 9122
               conn_id: 9081
                  user: app1@li1306-116.members.linode.com
                    db: tpcc5
               command: Sleep
                 state: NULL
                  time: 11
     current_statement: NULL
     statement_latency: NULL
              progress: NULL
          lock_latency: 0
         rows_examined: 0
             rows_sent: 0
         rows_affected: 0
            tmp_tables: 0
       tmp_disk_tables: 0
             full_scan: NO
        last_statement: COMMIT
last_statement_latency: 1945326000
        current_memory: 172047
             last_wait: NULL
     last_wait_latency: NULL
                source: NULL
           trx_latency: 9264917000
             trx_state: COMMITTED
        trx_autocommit: NO
                   pid: 17713
          program_name: NULL
1 row in set (0.55 sec)
```




Information by Client Hosts

```
mysql> select * from host_summary \G
*************************** 1. row ***************************
                  host: li1306-116.members.linode.com
            statements: 58027942
     statement_latency: 9.56 h
 statement_avg_latency: 592.85 us
           table_scans: 296
              file_ios: 67522180
       file_io_latency: 1.45 h
   current_connections: 20
     total_connections: 148
          unique_users: 2
        current_memory: 18.39 MiB
total_memory_allocated: 2.72 TiB
```




File IO by Hosts

```
mysql> select * from host_summary_by_file_io;
+------------------------------+------------+------------+
| host                         | ios        | io_latency |
+------------------------------+------------+------------+
| background                   | 110954519  | 7.63 h     |
| li174-63.members.linode.com  |  33872913  | 43.80 m    |
| li1306-116.members.linode.com|  33795434  | 43.66 m    |
| li534-125.members.linode.com |  33767097  | 43.08 m    |
| localhost                    |   1138434  | 1.23 m     |
+------------------------------+------------+------------+
5 rows in set (0.01 sec
```




Types of IO

```
mysql> select * from host_summary_by_file_io_type;
+-------------------------------+------------------------------------------------+----------+---------------+-------------+
| host                          | event_name                                     | total    | total_latency | max_latency |
+-------------------------------+------------------------------------------------+----------+---------------+-------------+
| background                    | wait/io/file/innodb/innodb_log_file            | 87369393 | 7.22 h        | 430.95 ms   |
| background                    | wait/io/file/innodb/innodb_data_file           | 22990098 | 16.77 m       | 134.75 ms   |
| background                    | wait/io/file/innodb/innodb_parallel_dblwrite_file |  387716 | 7.67 m        | 115.12 ms   |
| background                    | wait/io/file/sql/binlog                        |   232529 | 2.09 s        | 28.38 ms    |
| background                    | wait/io/file/innodb/innodb_temp_file           |      415 | 49.44 ms      | 2.32 ms     |
| background                    | wait/io/file/sql/slow_log                      |        7 | 5.05 ms       | 4.58 ms     |
| background                    | wait/io/file/sql/pid                           |        3 | 3.02 ms       | 2.97 ms     |
| background                    | wait/io/file/sql/ERRMSG                        |        5 | 2.05 ms       | 1.04 ms     |
| background                    | wait/io/file/sql/binlog_index                  |       36 | 1.71 ms       | 643.66 us   |
| background                    | wait/io/file/mysys/cnf                         |        5 | 1.58 ms       | 1.27 ms     |
| background                    | wait/io/file/sql/casetest                      |       15 | 1.24 ms       | 1.04 ms     |
| background                    | wait/io/file/mysys/charset                     |        3 | 426.80 us     | 408.13 us   |
| background                    | wait/io/file/sql/misc                          |        1 | 48.61 us      | 48.61 us    |
| li1306-116.members.linode.com | wait/io/file/sql/binlog                        |  3074720 | 19.91 m       | 116.84 ms   |
| li1306-116.members.linode.com | wait/io/file/innodb/innodb_data_file           |  1678043 | 15.42 m       | 173.48 ms   |
| li1306-116.members.linode.com | wait/io/file/sql/slow_log                      | 29049102 | 8.34 m        | 75.98 ms    |
| li1306-116.members.linode.com | wait/io/file/sql/binlog_index                  |      165 | 7.71 ms       | 2.32 ms     |
```




Statement Summary Per Host

```
mysql> select * from host_summary_by_statement_latency \G
*************************** 1. row
host: li174-63.members.linode.com
        total: 29175532
total_latency: 4.80 h
  max_latency: 51.14 s
 lock_latency: 37.47 m
    rows_sent: 13377371
rows_examined: 686152549
rows_affected: 20877010
   full_scans: 180
```




Statement Types Per Host

```
mysql> select host,statement,total,total_latency,rows_sent from host_summary_by_statement_type
limit 5;
+-------------------------------+-----------+----------+---------------+-----------+
| host                          | statement | total    | total_latency | rows_sent |
+-------------------------------+-----------+----------+---------------+-----------+
| background                    | select    |        1 | 36.99 ms      |         1 |
| li1306-116.members.linode.com | select    | 12812362 | 1.81 h        |  13354603 |
| li1306-116.members.linode.com | update    |  6825577 | 58.96 m       |         0 |
| li1306-116.members.linode.com | commit    |  1325481 | 58.02 m       |         0 |
| li1306-116.members.linode.com | insert    |  5232533 | 39.13 m       |         0 |
+-------------------------------+-----------+----------+---------------+-----------+
5 rows in set (0.02 sec)
```




File IO

```
mysql> select * from io_global_by_file_by_bytes limit 10;
+----------------------------------+------------+------------+-----------+-------------+---------------+-----------+------------+-----------+
| file                             | count_read | total_read | avg_read  | count_write | total_written | avg_write | total      | write_pct |
+----------------------------------+------------+------------+-----------+-------------+---------------+-----------+------------+-----------+
| @@datadir/xb_doublewrite         |          0 | 0 bytes    | 0 bytes   |      194812 | 298.55 GiB    | 1.57 MiB  | 298.55 GiB |    100.00 |
| @@datadir/mysql3-slow.log        |          0 | 0 bytes    | 0 bytes   |    88694996 | 67.25 GiB     | 814 bytes | 67.25 GiB  |    100.00 |
| @@datadir/tpcc5/order_line1.ibd |     342876 | 5.23 GiB   | 16.00 KiB |     1769489 | 27.00 GiB     | 16.00 KiB | 32.23 GiB  |     83.77 |
| @@datadir/tpcc1/order_line1.ibd |     341504 | 5.21 GiB   | 16.00 KiB |     1765234 | 26.94 GiB     | 16.00 KiB | 32.15 GiB  |     83.79 |
| @@datadir/tpcc3/order_line1.ibd |     335372 | 5.12 GiB   | 16.00 KiB |     1770525 | 27.02 GiB     | 16.00 KiB | 32.13 GiB  |     84.07 |
| @@datadir/tpcc4/order_line1.ibd |     327280 | 4.99 GiB   | 16.00 KiB |     1708848 | 26.07 GiB     | 16.00 KiB | 31.07 GiB  |     83.93 |
| @@datadir/tpcc2/order_line1.ibd |     320811 | 4.90 GiB   | 16.00 KiB |     1619925 | 24.72 GiB     | 16.00 KiB | 29.61 GiB  |     83.47 |
| @@datadir/tpcc5/stock1.ibd       |     398634 | 6.08 GiB   | 16.00 KiB |     1370460 | 20.91 GiB     | 16.00 KiB | 26.99 GiB  |     77.47 |
| @@datadir/tpcc2/stock1.ibd       |     397969 | 6.07 GiB   | 16.00 KiB |     1371018 | 20.92 GiB     | 16.00 KiB | 26.99 GiB  |     77.50 |
| @@datadir/tpcc1/stock1.ibd       |     398392 | 6.08 GiB   | 16.00 KiB |     1368650 | 20.88 GiB     | 16.00 KiB | 26.96 GiB  |     77.45 |
+----------------------------------+------------+------------+-----------+-------------+---------------+-----------+------------+-----------+
10 rows in set (0.02 sec)
```




IO by Event

```
mysql> select event_name,total_latency,total_read,total_written from io_global_by_wait_by_latency
limit 10;
+--------------------------------------+---------------+-------------+---------------+
| event_name                           | total_latency | total_read  | total_written |
+--------------------------------------+---------------+-------------+---------------+
| innodb/innodb_log_file               | 7.27 h        | 11.69 MiB   | 42.61 GiB     |
| innodb/innodb_data_file              | 1.06 h        | 86.82 GiB   | 298.79 GiB    |
| sql/binlog                           | 59.84 m       | 1.80 GiB    | 17.64 GiB     |
| sql/slow_log                         | 25.70 m       | 0 bytes     | 67.30 GiB     |
| innodb/innodb_parallel_dblwrite_file | 7.71 m        | 3.75 MiB    | 298.78 GiB    |
| innodb/innodb_temp_file              | 29.52 s       | 592.00 KiB  | 667.45 MiB    |
| sql/io_cache                         | 1.39 s        | 256.50 MiB  | 256.50 MiB    |
| sql/binlog_index                     | 28.18 ms      | 3.95 KiB    | 0 bytes       |
| sql/pid                              | 3.02 ms       | 0 bytes     | 6 bytes       |
| sql/ERRMSG                           | 2.05 ms       | 273.98 KiB  | 0 bytes       |
+--------------------------------------+---------------+-------------+---------------+
10 rows in set (0.01 sec)
```




Memory Allocation

```
mysql> select event_name, current_count, current_alloc from memory_global_by_current_bytes limit 10;
+----------------------------------------------------------------+---------------+---------------+
| event_name                                                     | current_count | current_alloc |
+----------------------------------------------------------------+---------------+---------------+
| memory/innodb/buf_buf_pool                                     |             4 | 533.00 MiB    |
| memory/temptable/physical_ram                                  |            95 | 95.00 MiB     |
| memory/sql/TABLE                                               |         19757 | 59.73 MiB     |
| memory/performance_schema/events_statements_summary_by_digest  |             1 | 39.67 MiB     |
| memory/performance_schema/events_errors_summary_by_thread_by_error |       257 | 34.38 MiB     |
| memory/innodb/ut0link_buf                                      |             2 | 24.00 MiB     |
| memory/performance_schema/table_handles                        |             2 | 18.12 MiB     |
| memory/innodb/memory                                           |         10443 | 17.96 MiB     |
| memory/performance_schema/events_errors_summary_by_user_by_error |         129 | 17.19 MiB     |
| memory/performance_schema/events_errors_summary_by_host_by_error |         129 | 17.19 MiB     |
+----------------------------------------------------------------+---------------+---------------+
10 rows in set (0.01 sec)
```




Enhanced Metrics Table

```
mysql> select * from metrics limit 10;
+-----------------------------+--------------------+----------------+---------+
| Variable_name               | Variable_value     | Type           | Enabled |
+-----------------------------+--------------------+----------------+---------+
| aborted_clients             | 154                | Global Status  | YES     |
| aborted_connects            | 446                | Global Status  | YES     |
| acl_cache_items_count       | 0                  | Global Status  | YES     |
| binlog_cache_disk_use       | 0                  | Global Status  | YES     |
| binlog_cache_use            | 4414737            | Global Status  | YES     |
| binlog_snapshot_file        | mysql3-bin.000163  | Global Status  | YES     |
| binlog_snapshot_position    | 871448732          | Global Status  | YES     |
| binlog_stmt_cache_disk_use  | 0                  | Global Status  | YES     |
| binlog_stmt_cache_use       | 382                | Global Status  | YES     |
| bytes_received              | 17290791216        | Global Status  | YES     |
+-----------------------------+--------------------+----------------+---------+
10 rows in set (0.04 sec)
```




Processlist – Includes Background

```
mysql> select * from processlist limit 1 \G
*************************** 1. row ***************************
                thd_id: 30
               conn_id: NULL
                  user: innodb/fts_optimize_thread
                    db: NULL
               command: NULL
                 state: NULL
                  time: 229883
     current_statement: NULL
     statement_latency: NULL
              progress: NULL
          lock_latency: NULL
         rows_examined: NULL
             rows_sent: NULL
         rows_affected: NULL
            tmp_tables: NULL
       tmp_disk_tables: NULL
             full_scan: NO
        last_statement: NULL
last_statement_latency: NULL
        current_memory: 1.91 KiB
             last_wait: NULL
     last_wait_latency: NULL
                source: NULL
           trx_latency: NULL
             trx_state: NULL
        trx_autocommit: NULL
                   pid: NULL
          program_name: NULL
1 row in set (0.30 sec)
```




Do not run out of auto_increment space

```
mysql> select * from schema_auto_increment_columns \G
*************************** 1. row ***************************
        table_schema: sbtest
          table_name: sbtest1
         column_name: id
           data_type: int
         column_type: int(11)
           is_signed: 1
         is_unsigned: 0
           max_value: 2147483647
      auto_increment: 1000000
auto_increment_ratio: 0.0005
1 row in set (0.01 sec)
```




Redundant Indexes

```
mysql> select * from schema_redundant_indexes \G
*************************** 1. row ***************************
              table_schema: sbtest
                table_name: sbtest1
      redundant_index_name: k_1
   redundant_index_columns: k
redundant_index_non_unique: 1
       dominant_index_name: k
    dominant_index_columns: k,c
 dominant_index_non_unique: 1
            subpart_exists: 0
            sql_drop_index: ALTER TABLE `sbtest`.`sbtest1` DROP INDEX
`k_1`
1 row in set (0.05 sec)
```




Table Access Statistics

```
mysql> select * from schema_table_statistics limit 5 \G
*************************** 1. row ***************************
     table_schema: tpcc1
       table_name: new_orders1
    total_latency: 15.37 m
     rows_fetched: 857480
    fetch_latency: 7.19 m
    rows_inserted: 288180
   insert_latency: 8.02 m
     rows_updated: 0
   update_latency: 0 ps
     rows_deleted: 284670
   delete_latency: 9.51 s
 io_read_requests: 246
          io_read: 3.89 MiB
  io_read_latency: 210.84 ms
io_write_requests: 8041
         io_write: 125.64 MiB
 io_write_latency: 3.39 s
 io_misc_requests: 6873
  io_misc_latency: 1.68 s
```




Unused Indexes

```
mysql> select * from schema_unused_indexes where
object_schema='tpcc1';
+---------------+-------------+---------------------+
| object_schema | object_name | index_name          |
+---------------+-------------+---------------------+
| tpcc1         | history1    | fkey_history_11     |
| tpcc1         | order_line1 | fkey_order_line_21  |
| tpcc1         | stock1      | fkey_stock_21       |
+---------------+-------------+---------------------+
3 rows in set, 1 warning (0.02 sec)
```




Are you using SSL ?

```
mysql> select * from session_ssl_status limit 10;
+-----------+------------+-------------------+--------------------+
| thread_id | ssl_version | ssl_cipher          | ssl_sessions_reused |
+-----------+------------+-------------------+--------------------+
|     12152 | TLSv1.1     | DHE-RSA-AES256-SHA | 0                   |
|     12158 |             |                    | 0                   |
|     12159 |             |                    | 0                   |
|     12160 |             |                    | 0                   |
|     12005 | TLSv1.1     | DHE-RSA-AES256-SHA | 0                   |
|     12006 | TLSv1.1     | DHE-RSA-AES256-SHA | 0                   |
|     12007 | TLSv1.1     | DHE-RSA-AES256-SHA | 0                   |
|     12008 | TLSv1.1     | DHE-RSA-AES256-SHA | 0                   |
|     12011 | TLSv1.1     | DHE-RSA-AES256-SHA | 0                   |
|     12012 | TLSv1.1     | DHE-RSA-AES256-SHA | 0                   |
+-----------+------------+-------------------+--------------------+
10 rows in set (0.00 sec)
```




Statements info

```
mysql> select * from statement_analysis limit 5,1 \G
*************************** 1. row ***************************
            query: SHOW GLOBAL STATUS
               db: NULL
        full_scan: *
       exec_count: 240568
        err_count: 0
       warn_count: 0
    total_latency: 20.88 m
      max_latency: 153.12 ms
      avg_latency: 5.21 ms
     lock_latency: 1.70 m
        rows_sent: 117878320
    rows_sent_avg: 490
    rows_examined: 235756640
rows_examined_avg: 980
    rows_affected: 0
rows_affected_avg: 0
       tmp_tables: 240568
  tmp_disk_tables: 0
      rows_sorted: 0
sort_merge_passes: 0
           digest: 070e38632eb4444e50cdcbf0b17474ba801e203add89783a24584951442a2317
       first_seen: 2019-06-11 19:01:32.245462
        last_seen: 2019-06-14 13:50:07.158611
1 row in set (0.01 sec)
```




Errors and Warnings ?

```
mysql> select * from statements_with_errors_or_warnings limit 1 \G
*************************** 1. row ***************************
      query: SELECT `no_o_id` FROM `new_ord ... o_o_id` ASC LIMIT ? FOR UPDATE
         db: tpcc1
 exec_count: 298942
     errors: 7
  error_pct: 0.0023
   warnings: 0
warning_pct: 0.0000
 first_seen: 2019-06-11 19:02:31.104121
  last_seen: 2019-06-14 13:52:57.834563
     digest: 366d8c4aa612adf0ec3e06cb020fd395e1da1fd4f6b676530c214771aed00b55
1 row in set (0.01 sec)
```




User Info

```
mysql> select * from  user_summary limit 1 \G
*************************** 1. row ***************************
                  user: app1
            statements: 195012171
     statement_latency: 1.38 d
 statement_avg_latency: 612.32 us
           table_scans: 1428
              file_ios: 226986594
       file_io_latency: 4.96 h
   current_connections: 36
     total_connections: 476
          unique_hosts: 3
        current_memory: 125.39 MiB
total_memory_allocated: 9.13 TiB
1 row in set (0.08 sec)
```




More Wait Info (If Enabled)

```
mysql> select  events, total, total_latency  from waits_global_by_latency limit 10;
+---------------------------------------------------+------------+---------------+
| events                                            | total      | total_latency |
+---------------------------------------------------+------------+---------------+
| wait/io/file/innodb/innodb_log_file               |  108966439 | 9.17 h        |
| wait/io/table/sql/handler                         | 2615937816 | 5.41 h        |
| wait/io/file/innodb/innodb_data_file              |   34980007 | 1.35 h        |
| wait/io/file/sql/binlog                           |   11738591 | 1.25 h        |
| wait/io/file/sql/slow_log                         |  109842706 | 32.11 m       |
| wait/io/file/innodb/innodb_parallel_dblwrite_file |     483426 | 9.70 m        |
| wait/lock/table/sql/handler                       |  101720352 | 2.82 m        |
| wait/io/file/innodb/innodb_temp_file              |      24212 | 39.62 s       |
| wait/io/file/sql/io_cache                         |      18961 | 2.29 s        |
| wait/io/file/sql/binlog_index                     |        731 | 38.33 ms      |
+---------------------------------------------------+------------+---------------+
10 rows in set (0.01 sec)
```




Latency Distributions

```
mysql> select * from
events_statements_histogram_global limit 1 \G
*************************** 1. row
***************************
          BUCKET_NUMBER: 0
       BUCKET_TIMER_LOW: 0
      BUCKET_TIMER_HIGH: 10000000
           COUNT_BUCKET: 162125
 COUNT_BUCKET_AND_LOWER: 162125
        BUCKET_QUANTILE: 0.001473
1 row in set (0.00 sec)
```




Logs

Error Log

General Query Log

Slow Query Log

Percona Server supports Sampling



Slow Query Log (Percona Server)

```
# Time: 2019-06-14T14:07:29.062441Z
# User@Host: app1[app1] @ li534-125.members.linode.com [50.116.47.125]  Id:  7442
# Schema: tpcc1  Last_errno: 0  Killed: 0
# Query_time: 0.000635  Lock_time: 0.000123  Rows_sent: 0  Rows_examined: 0  Rows_affected: 1
# Bytes_sent: 11  Tmp_tables: 0  Tmp_disk_tables: 0  Tmp_table_sizes: 0
# InnoDB_trx_id: 366322C
# Full_scan: No  Full_join: No  Tmp_table: No  Tmp_table_on_disk: No
# Filesort: No  Filesort_on_disk: No  Merge_passes: 0
#   InnoDB_IO_r_ops: 0  InnoDB_IO_r_bytes: 0  InnoDB_IO_r_wait: 0.000000
#   InnoDB_rec_lock_wait: 0.000000  InnoDB_queue_wait: 0.000000
#   InnoDB_pages_distinct: 7
SET timestamp=1560521249;
INSERT INTO order_line1
                                 (ol_o_id, ol_d_id, ol_w_id, ol_number, ol_i_id, ol_supply_w_id,
ol_quantity, ol_amount, ol_dist_info)
                          VALUES (181228,6,1,9,31509,1,3,169,'xxxxxxxxxxxxxxxxxxxxxxxx');
```




MySQL 8.0.14+ Extends Slow Query Log

```
# Time: 2019-06-14T14:14:22.980797Z
# User@Host: root[root] @ localhost []  Id:     8
# Query_time: 0.005342  Lock_time: 0.000451 Rows_sent: 33
Rows_examined: 197 Thread_id: 8 Errno: 0 Killed: 0
Bytes_received: 0 Bytes_sent: 664 Read_first: 1 Read_last:
0 Read_key: 71 Read_next: 127 Read_prev: 0 Read_rnd: 33
Read_rnd_next:
34 Sort_merge_passes: 0 Sort_range_count: 0 Sort_rows: 33
Sort_scan_count: 1 Created_tmp_disk_tables: 0
Created_tmp_tables: 1 Start: 2019-06-14T14:14:22.975455Z
 End: 2019-06-14T14:14:22.980797Z
SET timestamp=1560521662;
show tables;
```




EXPLAIN

Understand Query Execution Plan

Essential Skill for Developers and DBAs

Multiple Output Formats

Can get EXPLAIN plan for actual running query



Basic Explain

```
mysql> explain SELECT o_c_id        FROM orders1     WHERE o_id = 180962    AND o_d_id = 10
AND o_w_id = 1 \G
*************************** 1. row ***************************
           id: 1
  select_type: SIMPLE
        table: orders1
   partitions: NULL
         type: const
possible_keys: PRIMARY,idx_orders1
          key: PRIMARY
      key_len: 7
          ref: const,const,const
         rows: 1
     filtered: 100.00
        Extra: NULL
1 row in set, 1 warning (0.00 sec)
```




JSON Explain

```
mysql> explain format=json SELECT o_c_id                                    FROM orders1
WHERE o_id = 180962                                     AND o_d_id = 10
AND o_w_id = 1 \G
*************************** 1. row ***************************
EXPLAIN: {
  "query_block": {
    "select_id": 1,
    "cost_info": {
      "query_cost": "1.00"
    },
    "table": {
      "table_name": "orders1",
      "access_type": "const",
      "possible_keys": [
        "PRIMARY",
        "idx_orders1"
      ],
      "key": "PRIMARY",
      "used_key_parts": [
        "o_w_id",
        "o_d_id",
        "o_id"
      ],
      "key_length": "7",
      "ref": [
        "const",
        "const",
        "const"
      ],
      "rows_examined_per_scan": 1,
      "rows_produced_per_join": 1,
      "filtered": "100.00",
      "cost_info": {
        "read_cost": "0.00",
        "eval_cost": "0.10",
        "prefix_cost": "0.00",
        "data_read_per_join": "24"
      },
      "used_columns": [
        "o_id",
        "o_d_id",
        "o_w_id",
        "o_c_id"
      ]
    }
  }
}
1 row in set, 1 warning (0.02 sec)
```




TREE Format (8.0.16+)

```
EXPLAIN: -> Aggregate: count(0)
    -> Filter: ((t1.c1 + t1.c_ytd_payment) <> t1.sm)
        -> Table scan on t1
            -> Materialize
                -> Index lookup on c using PRIMARY (c_w_id=1)
                -> Select #3 (subquery in projection; dependent)
                    -> Aggregate: sum(order_line1.ol_amount)
                        -> Nested loop inner join
                            -> Index lookup on orders1 using idx_orders1 (o_w_id       =c.c_w_id, o_d_id=c.c_d_id, o_c_id=c.c_id)
                            -> Filter: ((order_line1.ol_d_id = orders1.o_d_id) and (order_line1.ol_w_id = orders1.o_w_id) and
                                 (order_line1.ol_delivery_d is not null))
                                -> Index lookup on order_line1 using PRIMARY (ol   _w_id=c.c_w_id, ol_d_id=c.c_d_id,
                                           ol_o_id=orders1.o_id)
```




EXPLAIN ANALYZE

```
mysql> EXPLAIN ANALYZE SELECT * FROM t1 JOIN t2 ON (t1.c1 = t2.c2)\G
*************************** 1. row ***************************
EXPLAIN: -> Inner hash join (t2.c2 = t1.c1)  (cost=4.70 rows=6)
(actual time=0.032..0.035 rows=6 loops=1)
    -> Table scan on t2  (cost=0.06 rows=6)
(actual time=0.003..0.005 rows=6 loops=1)
    -> Hash
        -> Table scan on t1  (cost=0.85 rows=6)
(actual time=0.018..0.022 rows=6 loops=1)
```

https://www.percona.com/blog/2019/10/28/using-explain-analyze-in-mysql-8/



EXPLAIN FOR CONNECTION

```
mysql [localhost] {msandbox} ((none)) > explain for connection 9 (
*************************** 1. row ***************************
           id: 1
  select_type: SIMPLE
        table: employees
   partitions: NULL
         type: ALL
possible_keys: NULL
          key: NULL
      key_len: NULL
          ref: NULL
         rows: 299540
     filtered: 100.00
        Extra: NULL
*************************** 2. row ***************************
           id: 1
  select_type: SIMPLE
        table: salaries
   partitions: NULL
         type: ALL
possible_keys: NULL
          key: NULL
      key_len: NULL
          ref: NULL
         rows: 2803840
     filtered: 100.00
        Extra: Using where; Using join buffer (Block Nested Loop)
```




Tracing Optimizer

```
# Turn tracing on (it's off by default):
SET optimizer_trace="enabled=on";
SELECT ...;
# your query here
SELECT * FROM
INFORMATION_SCHEMA.OPTIMIZER_TRACE;
# possibly more queries...
# When done with tracing, disable it:
SET optimizer_trace="enabled=off";
```

https://dev.mysql.com/doc/internals/en/optimizer-tracing.html



Percona Monitoring and Management

Open Source Database Focused Observability Solution from Percona

100% Free and Open Source

http://per.co.na/PMM





Demo Time

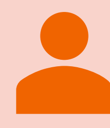
DEMO



Want to learn more about PMM



Come to Percona Booth to see the Demo and get your questions answered



Our team can also can help you to install PMM



If you have PMM installed already we can give you some tips on how to use it to improve your database



Custom Dashboards shown in the Demo

https://www.percona.com/blog/2020/11/02/understanding-mysql-memory-usage-with-performance-schema/

https://www.percona.com/blog/2021/04/22/understanding-processes-running-on-linux-host-with-percona-monitoring-and-management/

https://www.percona.com/blog/2020/07/15/mysql-query-performance-troubleshooting-resource-based-approach/

https://www.percona.com/blog/2020/06/17/red-method-for-mysql-performance-analyses/



Which Queries are Causing the Load

Filters   Show Selected   Reset All

Add column

Filter by...

Environment

- mytest 99.99%
- n/a <0.01%

Database

- n/a 99.99%
- postgres <0.01%
- pmm-managed <0.01%

Schema Show all (7)

- tpcc1 44.2%
- tpcc5 11.41%
- tpcc4 11.4%
- tpcc2 11.29%
- tpcc3 11.2%

#	Query	Load	Query Count	Query Time
	TOTAL	34.83 load	2.74k QPS	12.7
1	update warehouse1 set w_ytd = w_ytd + ? where w_id = ?	10.99 load	24.03 QPS	457.28
2	select i_price, i_name, i_data from item1 where i_id = ?	4.95 load	241.47 QPS	20.4
3	select c from sbtest1 where id=?	3.15 load	988.38 QPS	3.1
4	select d_next_o_id, d_tax from district1 where d_w_id = ?...	2.87 load	24.17 QPS	118.5
5	update district1 set d_ytd = d_ytd + ? where d_w_id = ? a...	2.41 load	24.02 QPS	100.2
6	select o_id from orders1 o, (select o_c_id,o_w_id,o_d_id,...	1.62 load	24.23 QPS	66.7
7	insert into new_orders1 (no_o_id, no_d_id, no_w_id) valu...	1.14 load	24.17 QPS	47.2
8	insert into order_line1 (ol_o_id, ol_d_id, ol_w_id, ol_numb...	0.93 load	241.23 QPS	3.8
9	update stock1 set s_quantity = ? where s_i_id = ? and s_...	0.83 load	241.23 QPS	3.4

< 1 2 3 4 5 ••• 33 >   10 / page   1-10 of 325 items



Why Are they Causing this Load

Details | Examples | Explain | Tables | Close

Query time distribution

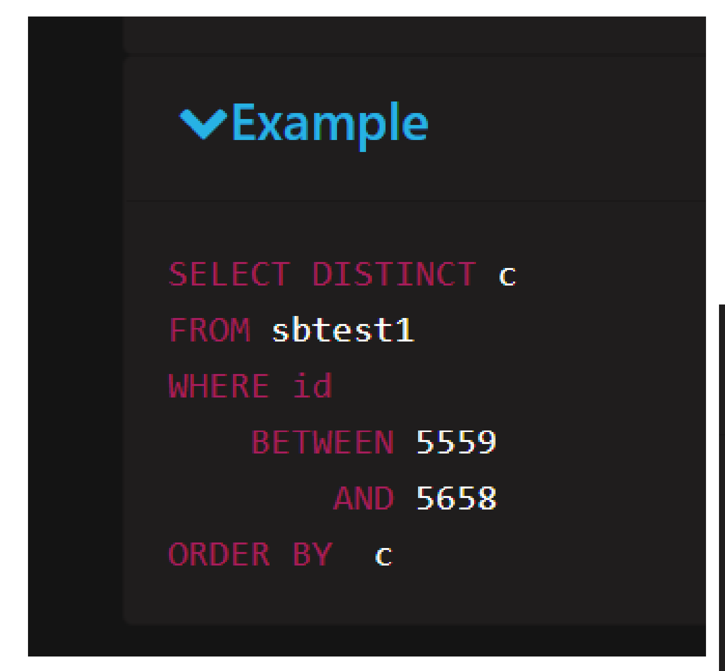
Lock Time: 98.91% | In

Metrics

Metric	Rate/Second	Sum	Per Query Stats
Query Count	24.06 QPS	1.04m 0.88% of total	1.00
Query Count with errors	<0.01 QPS	345.00 0.03% of total	0.00
Query Time	11.00 load	5 days, 12:01:41 31.55% of total	457.20 ms
Lock Time	10.88 (avg load)	5 days, 10:35:06 58.07% of total 98.91% of query time	452.20 ms
Rows Examined	24.06 (per sec)	1.04m	1.00



How to Improve their Performance



CREATE

```
CREATE TABLE `sbtest1` (
  `id` int(10) unsigned NOT NULL AUTO_INCREMENT,
  `k` int(10) unsigned NOT NULL DEFAULT '0',
  `c` char(120) NOT NULL DEFAULT '',
  `pad` char(60) NOT NULL DEFAULT '',
  PRIMARY KEY (`id`),
  KEY `k_1` (`k`)
) ENGINE=InnoDB AUTO_INCREMENT=100000001 DEFAULT
```

JSON

Expand All


```
-{
  "query_block": -{
    "select_id": 1,
    "cost_info": +{...},
    "ordering_operation": -{
      "using_filesort": false,
      "duplicates_removal": -{
        "using_temporary_table": true,
        "using_filesort": true,
        "cost_info": +{...},
        "table": +{...}
```




System Monitoring

OS > Node Summary

Last 12 hours 1m

System Uptime 3.62 weeks
Virtual CPUs 1
Load Average 18.50
Disk Space 24.06 GiB
Min Space Available 61%
Time before run out of space 2.42 weeks
RAM 985.08 MiB
Memory Available 17%
Virtual Memory 2.46 GiB

DB Service Connections
MySQL - mysql1-mysql
96

Service Types

Type	Amount
mysql	1

CPU

CPU Usage

	min	max	avg
user	47.81%	64.46%	55.70%
system	20.36%	36.64%	28.55%

CPU Saturation and Max Core Usage

	min	max	avg
Normalized CPU Load	4.63	38.50	19.49
Max CPU Core Utilization (right-y)	77.21%	99.97%	87.42%

Interrupts and Context Switches

Processes

74.207.232.64/graph



MySQL Instance Summary

MySQL > MySQL Instance Summary

Last 12 hours · 1m

Interval: auto · Environment: All · Service Name: mysql1-mysql · PMM Annotations

Home · Query Analytics · Compare · MySQL · HA · Services · PMM

Home Dashboard > Node Summary > MySQL Instance Summary

Node	MySQL Uptime	Version	Current QPS	InnoDB Buffer Pool Size	Buffer Pool Size of Total RAM
mysql1...	3.62 weeks	8.0.19-10	953.96	256 MiB	26%

Connections

MySQL Connections

	min	max	avg
Max Connections	151	151	151
Max Used Connections	105	105	105

MySQL Aborted Connections

	min	max	avg
Aborted Connects (attempts)	0 ops	0.41 ops	0.00 ops
Aborted Clients (timeout)	0 ops	0.36 ops	0.00 ops

Client Threads

MySQL Client Thread Activity

	min	max	avg
Peak Threads Connected	93.00	100.00	96.19
Peak Threads Running	5.00	93.00	70.86

MySQL Thread Cache

	min	max	avg
Thread Cache Size	9.00	9.00	9.00
Threads Cached	6.00	9.00	8.54

74.207.232.64/graph



Advanced Performance Schema Analyses

MySQL / MySQL Performance Schema Wait Event Analyses

Last 12 hours Refresh every 1m

Data for mysql1 with 5m resolution

Count - Performance Schema Waits

600 ops
500 ops
400 ops
300 ops
200 ops
100 ops
0 ops

00:00 01:00 02:00 03:00 04:00 05:00 06:00 07:00 08:00 09:00 10:00 11:00

	min	max	avg
wait/io/file/innodb/innodb_log_file	422.88 ops	514.78 ops	479.42 ops

Load - Performance Schema Waits

0.40
0.30
0.20
0.10
0

00:00 01:00 02:00 03:00 04:00 05:00 06:00 07:00 08:00 09:00 10:00 11:00

	min	max	avg
wait/io/file/innodb/innodb_log_file	0.15	0.36	0.23



Innodb Insights

MySQL > MySQL InnoDB Details

Last 3 hours 1m

Home Dashboard > Node Summary > MySQL Instance Summary > MySQL InnoDB Compression Details

Data for mysql1-mysql running on mysql1 with 1m resolution

Buffer Pool Size	Buffer Pool Size of Total R...	Total Redo Log Space	Max Log Space Used	Max Transaction History Le...	Data Bandwidth	Fsync Rate	Row Lock Blocking
256 MiB	25.99%	2.00 GiB	0.48%	378.00	9.52 MBs	364.19 ops	31.68%

InnoDB Activity

Writes (Rows)	Writes (Transactions)	Row Writes per Trx	Rows Read Per Trx	Log Space per Trx	Rollbacks	BP Reqs Per Row	Log Fsync Per Trx
3.96%	3.03%	19.41	15.06	11.90 KiB	0.38%	1.23	10.56

InnoDB Row Reads

	min	max	avg
Rows operation	3.49 K	14.09 K	7.80 K

InnoDB Row Writes

	min	max	avg
Rows updated	115.62	210.13	160.65
Rows inserted	75.07	116.96	90.33

InnoDB Read-Only Transactions

	min	max	avg
Non Locking RO Transaction Commits	389.75	784.29	499.47
RO Transaction Commits	1.93	10.27	5.02

InnoDB Read-Write Transactions

	min	max	avg
RW Transactions Completed	11.67	22.89	15.80
Rollback Rate (right-y)	0%	1.39%	0.38%



See it Live!

https://pmmdemo.percona.com



Thank You!
Twitter: @percona @peterzaitsev